Lucerne Breeding and Agronomy update

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SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
PIRSA

PREMIUM FOOD AND WINE FROM OUR CLEAN ENVIRONMENT

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OVERVIEW

Role of Lucerne

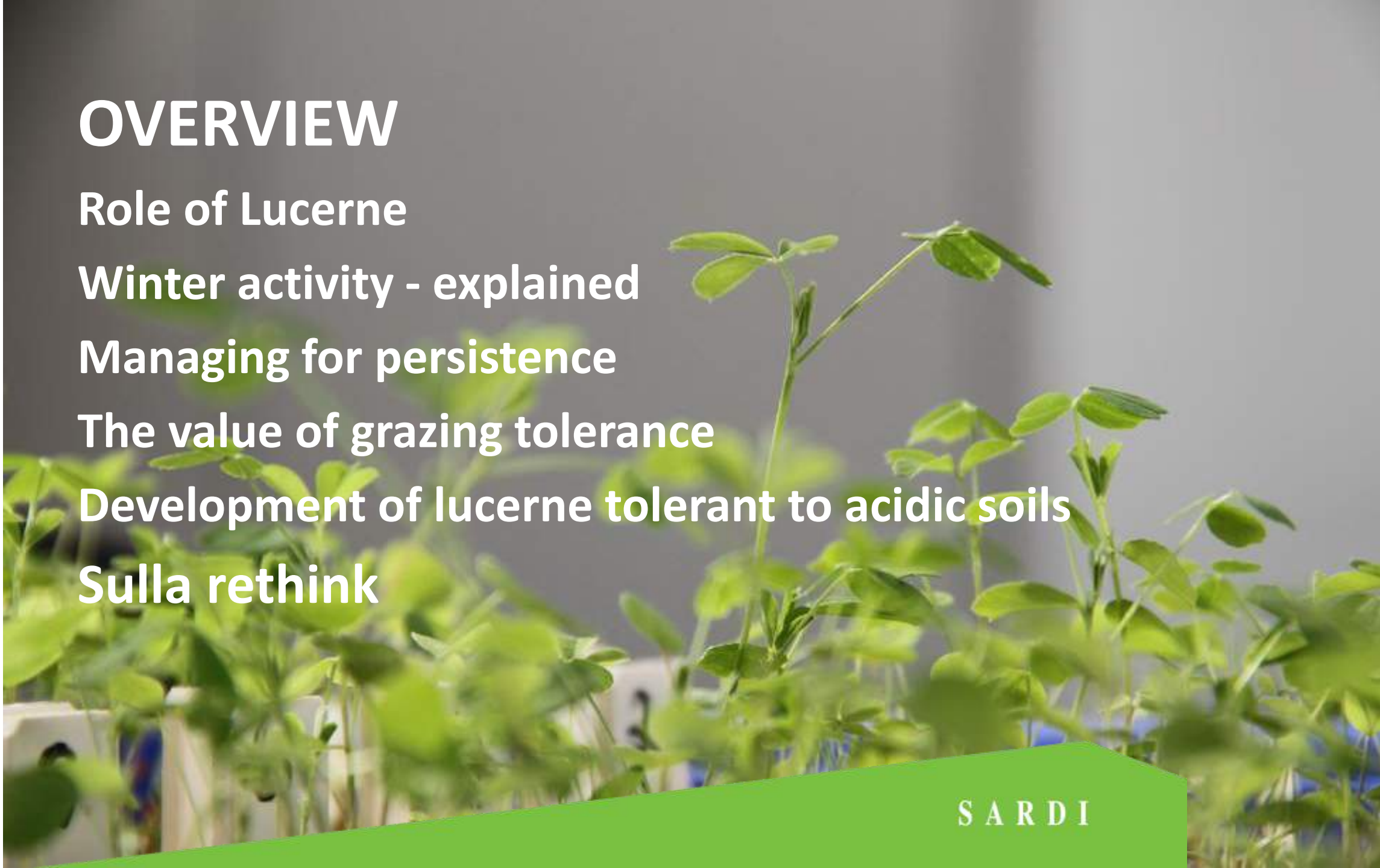
Winter activity - explained

Managing for persistence

The value of grazing tolerance

Development of lucerne tolerant to acidic soils

Sulla rethink




Legume, grass and herb trials
- 150 species evaluated for seasonal patterns in yield and nutritive value
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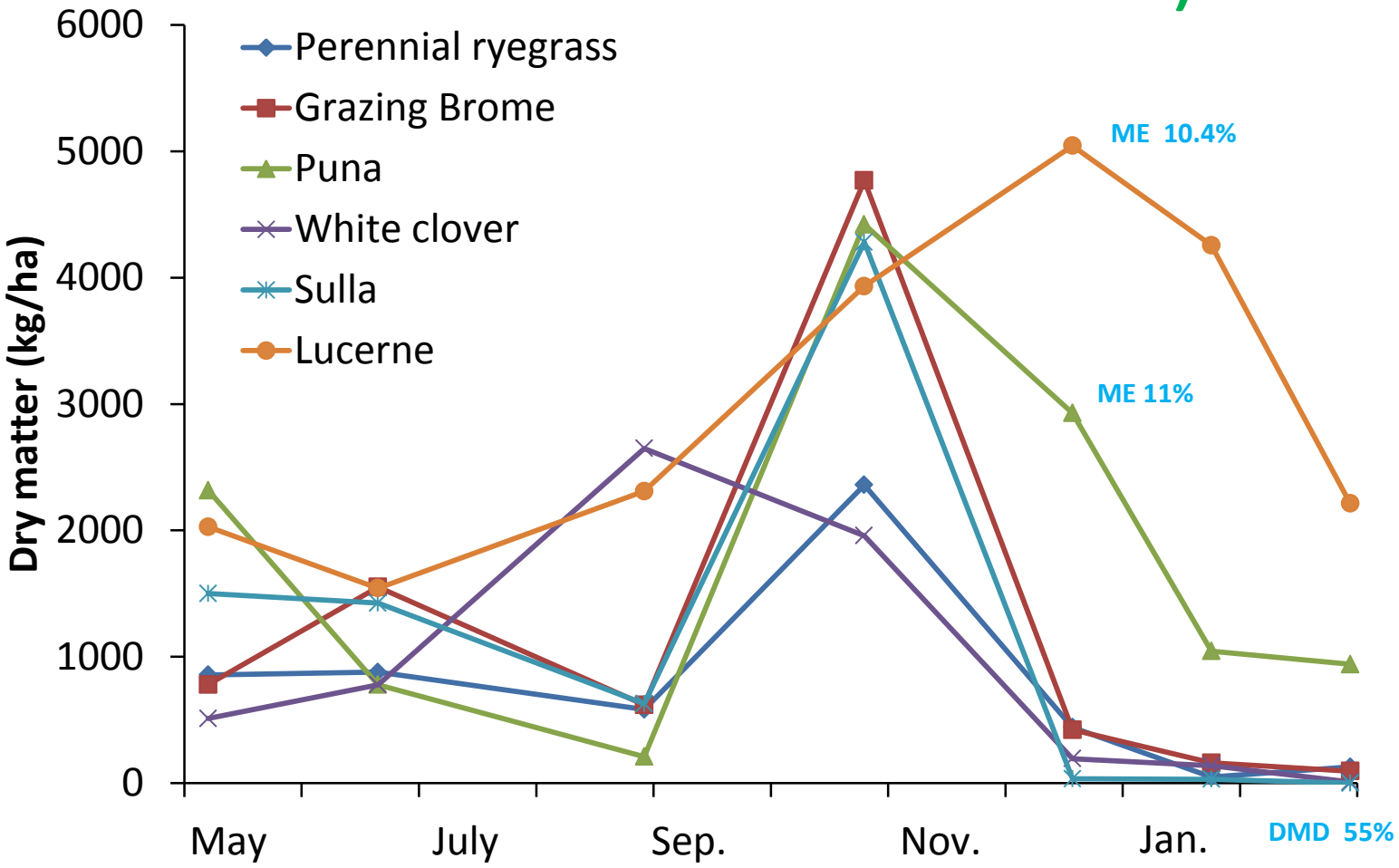
Overview of Perennials (2nd year rainfed at Waite Institute)



Lucerne and Chicory had high DMD & forage yield, and were the only species to provide new, green highly digestible forage in summer and Autumn.

We can use the extended growing season to get cattle to market in less time

It should be possible to reduce this gap by extending the growing season of the feedbase: Lucerne, chicory and bromegrass provide new options to achieve this

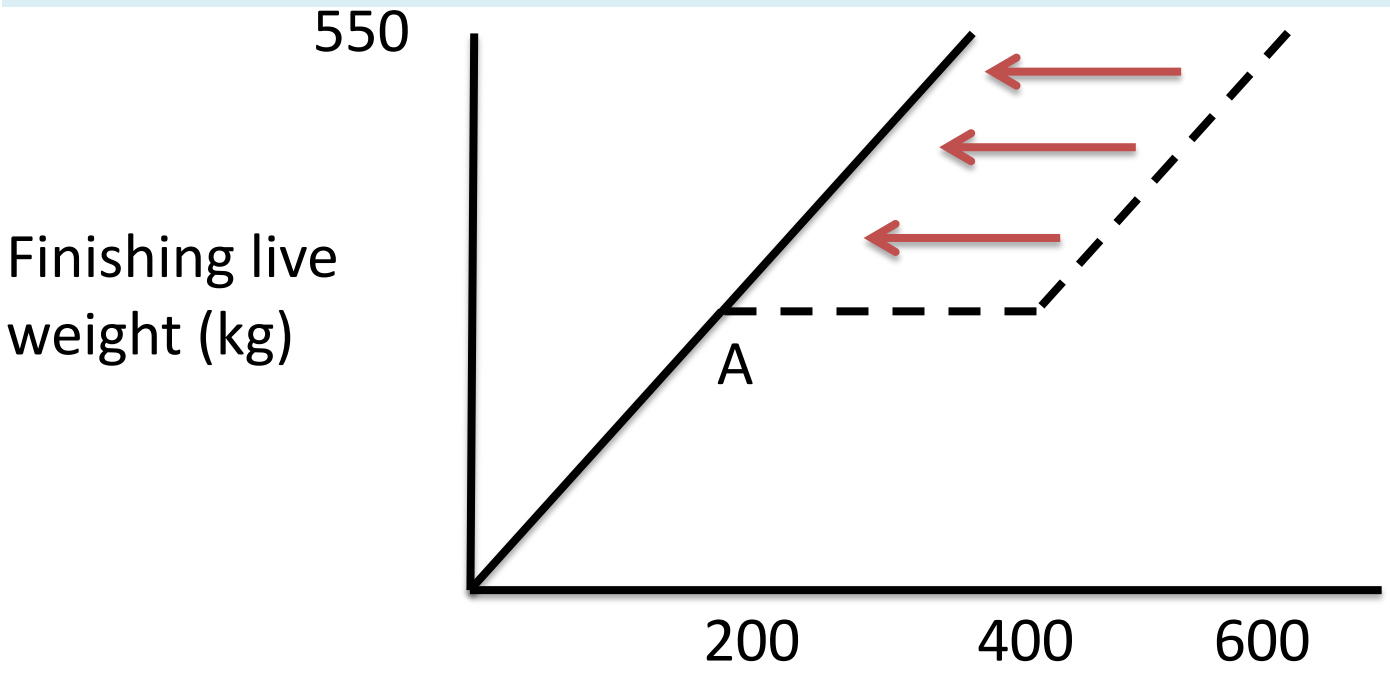


Diagram from W. Pitchford *pers. comm.* 2011

“Adding P and using lucerne predicted to have the greatest effect in recovering from the negative impact of climate change on profitability”

(Gharamani and Moore 2013)

- Shifts in the seasonal pattern of rainfall towards greater summer rainfall.
- Providing green forage at times of feed shortage
- Variability in lucerne nutritive value under moisture stress shows a 3 fold difference in live weight gain in existing cultivars (Hughes *et al* 2012).

Winter Activity

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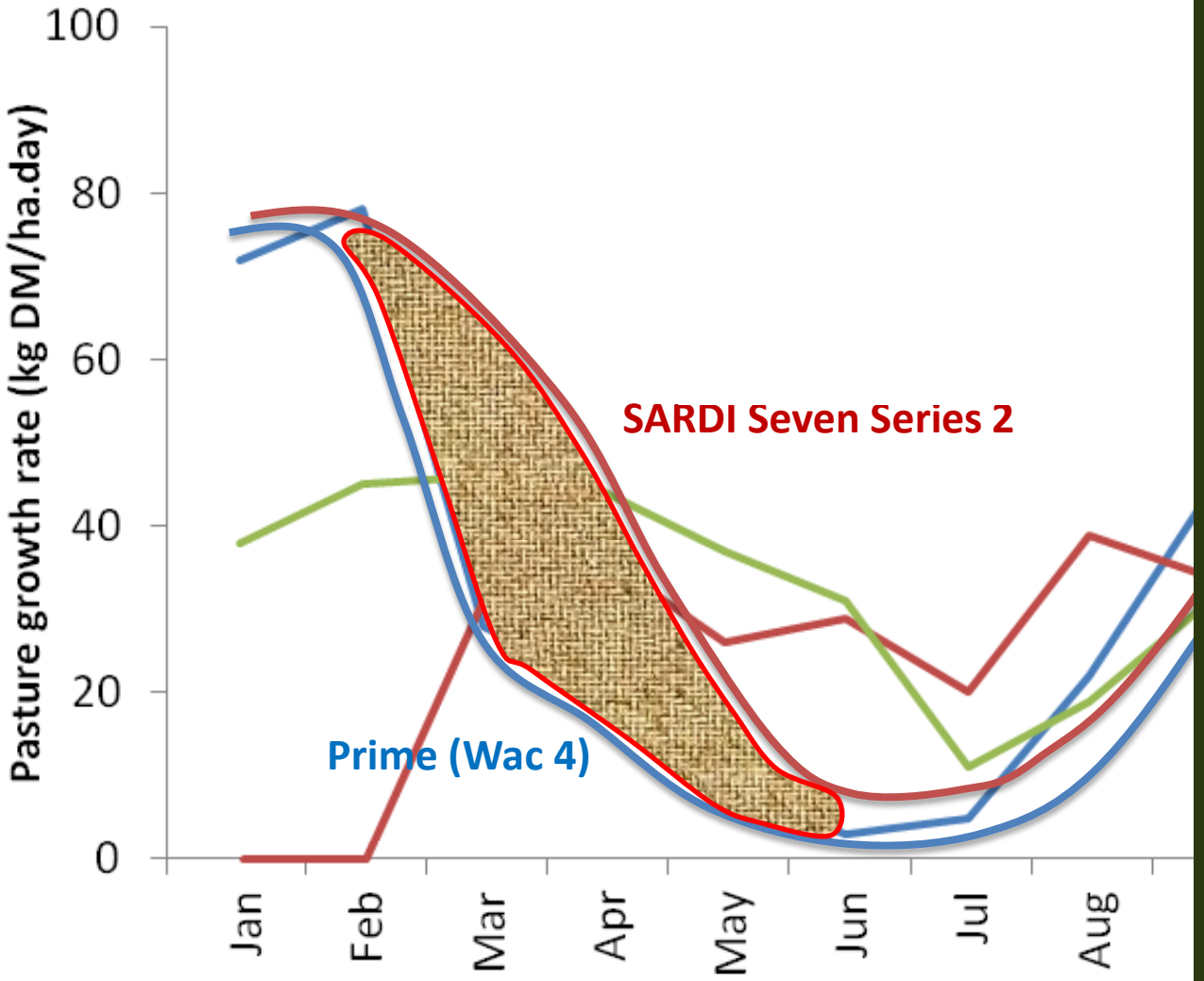
Herbage growth rates (averaged over 4 years) for irrigated lucerne subterranean clover and ryegrass and white clover, from Kelly *et al.* (2005)



SARDI 7 Series 2 selected:

Cold and Wet:

Coleraine Vic
Mount Gambier SA
East Wagga NSW
Cootamundra, NSW

The Festy

Langhorne Creek, SA
Ponde, SA
Inglewood, Qld
Aberdeen, NSW

The Tough

Turretfield CGT, SA Inverell
Canowindra, NSW
Parkes, NSW

Which winter activity?

SARDI Five: Hay enterprise or cold wet environment where a Wac 5 is specifically required.

SARDI Grazer (6): Anywhere where persistence is the key criteria and or a long grazing rotation required (20-35 days grazing, 35 days recovery).

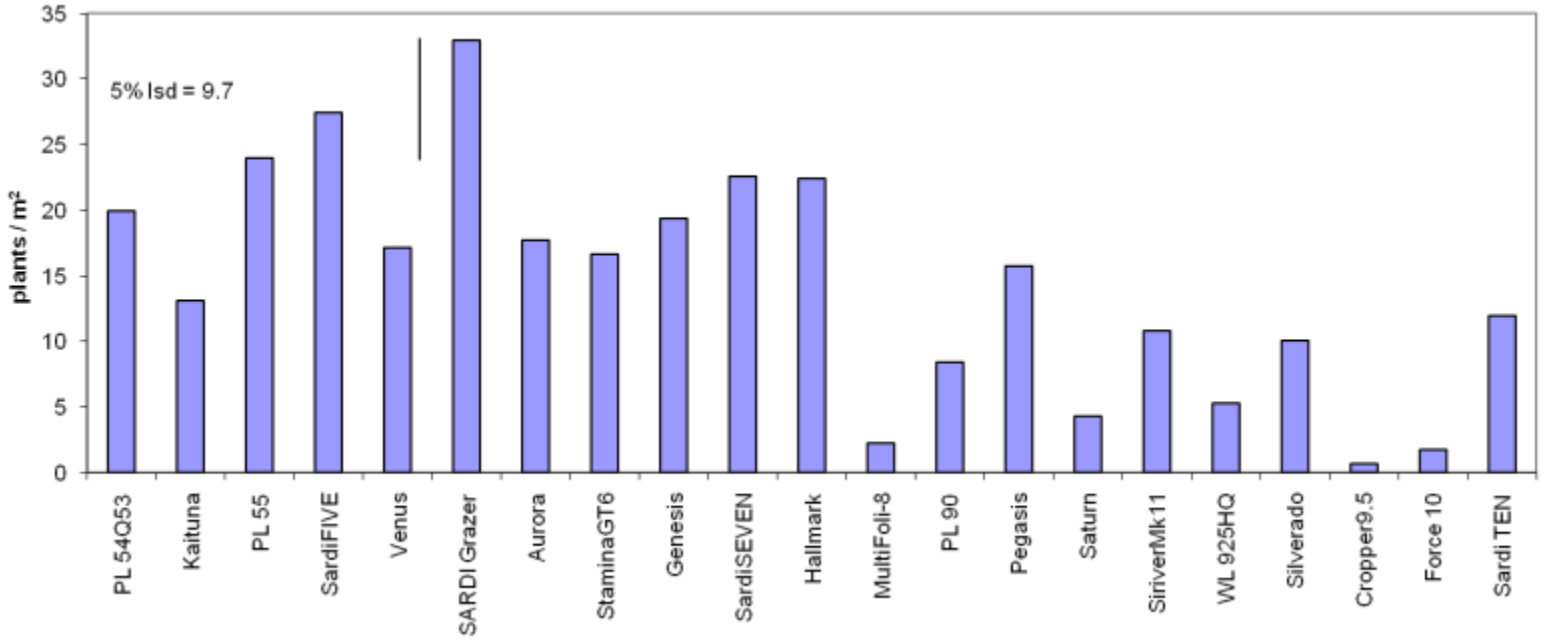
SARDI Seven series 2: Multipurpose lucerne for permanent pastures (>6 years). A very persistent lucerne, biggest advantage in cold, wet environments. Use in favour of SARDI Grazer where better grazing management is used and make use of improved autumn-winter production.

SARDI Ten series 2: Very highly winter active, for short rotations (3-6 years) where rotational grazing is practiced. Cropping systems / dairies & other intensive production.

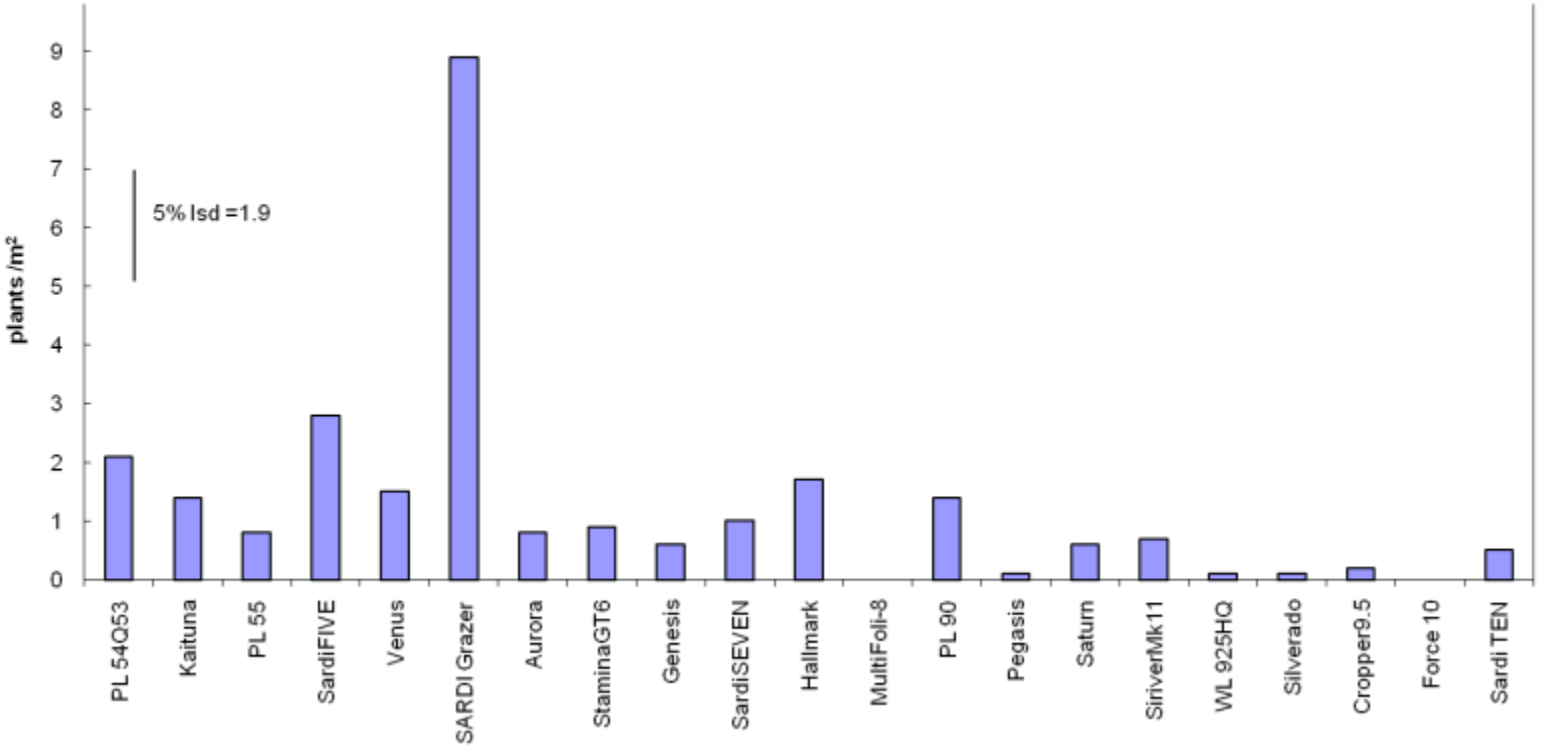
Breeding for improved tolerance to grazing

Turretfield Continuous Grazing Trial, SA March 1999

After 8 months of grazing



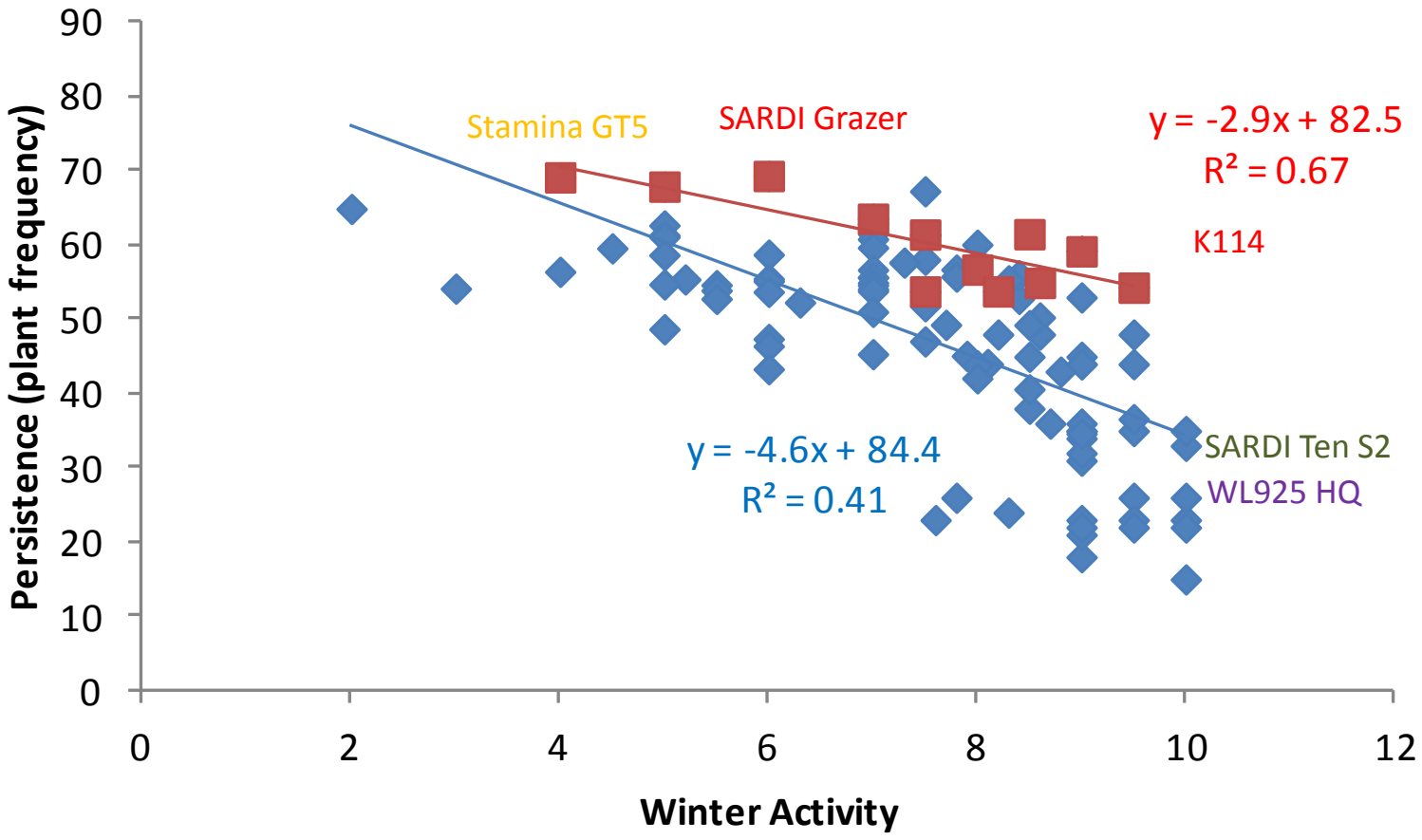
After 12 months



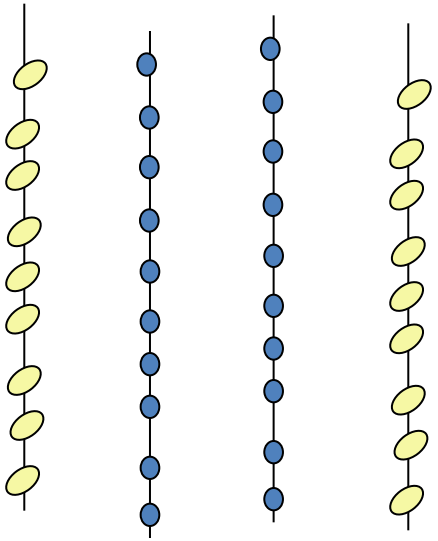
After 18 months

Value of Grazing tolerance trait

Average performance after 4 years at Coolac, Cowra, Culcairn, Grenfell, Mingbool, Bendigo, Timboon, Rochester, Tintinarra.



Establishment with Cover Crops – please recommend



Wheat and lucerne seeds in separate rows

Low competition

after Roy Latta

Alfalfa-Tall Fescue establishment– Great Southern Plains, USA

Alternating drill row (L) and drill pass (R)

Alternating and perpendicular row "checker board" orientation

Source: Twain Butler Noble Foundation, **Novel Approaches to Establishing Alfalfa-Tall Fescue Pastures in the Southern Great Plains (2011)**

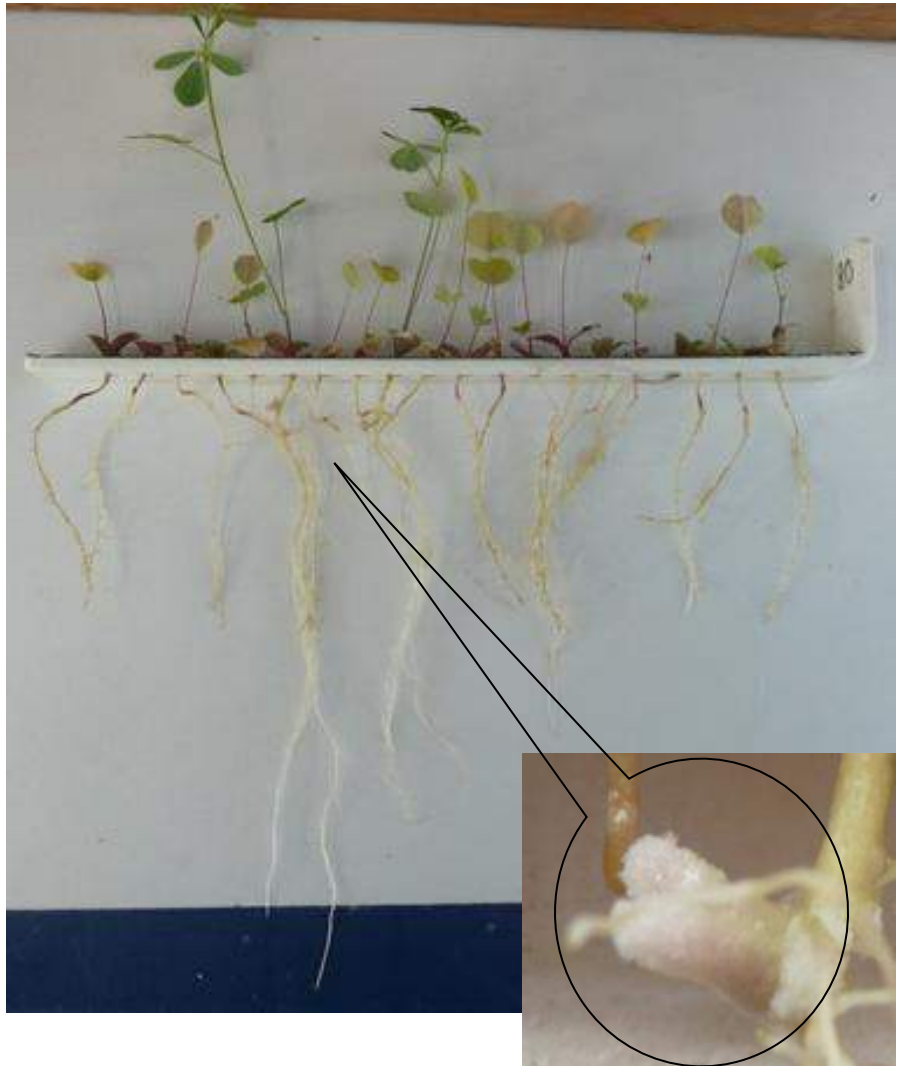
Grazing Management – Managing for persistence

- Recovery is the most important part, not how long you graze lucerne for.
- Short grazing rotations (1 week grazing – 6 weeks recovery) are the most productive, avoid grazing new shoots. *But* many farmers have Lucerne for >10 years with much longer grazing rotations.
- Grazing for 6-8 weeks in winter based on the volunteer pasture. But avoid multiple stresses: competition, waterlogging, continuous grazing, acid soils.
- Hay cut in Spring to bring everything back to ground
- Lengthen recovery period (to 6-8 weeks) in late spring and summer with recharge the lucerne, and give it dominance over grasses by shading
  - Old rules, flowering once a year, not a bad one.
  - Derek Moot (NZl) talks about physiology of carbohydrate storage, importance in autumn
  - From Oct – June manage for lucerne to get the most out of it – grow a crop and cut it down.
- If grass dominates: extend recovery, graze harder (closer to ground) or cut, avoid nitrogen
- If lucerne dominates: shorten recovery, add nitrogen

Redefining the tolerance of lucerne to acidic soils

- **Poor root growth**
  - Tolerance to low pH
  - Aluminium toxicity

- Poor nodulation
  - **Survival of Rhizobia in soil**
  - **Nodulation potential of plant**



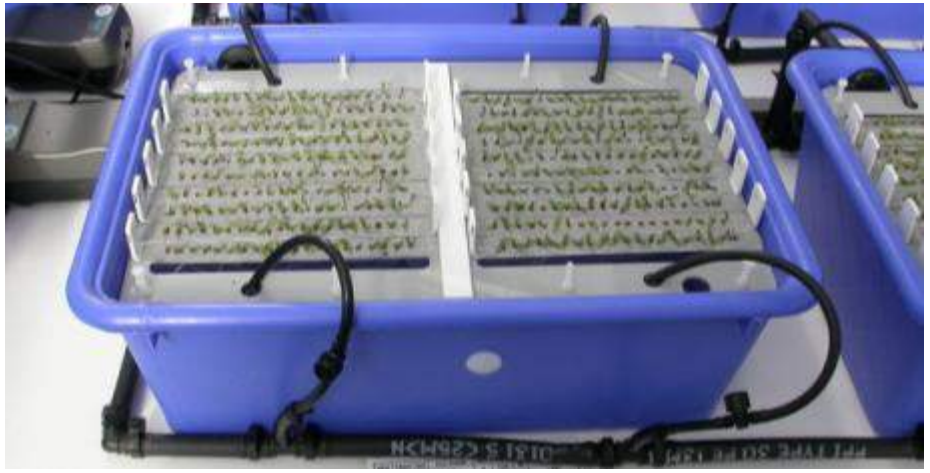
Selection for improved root growth

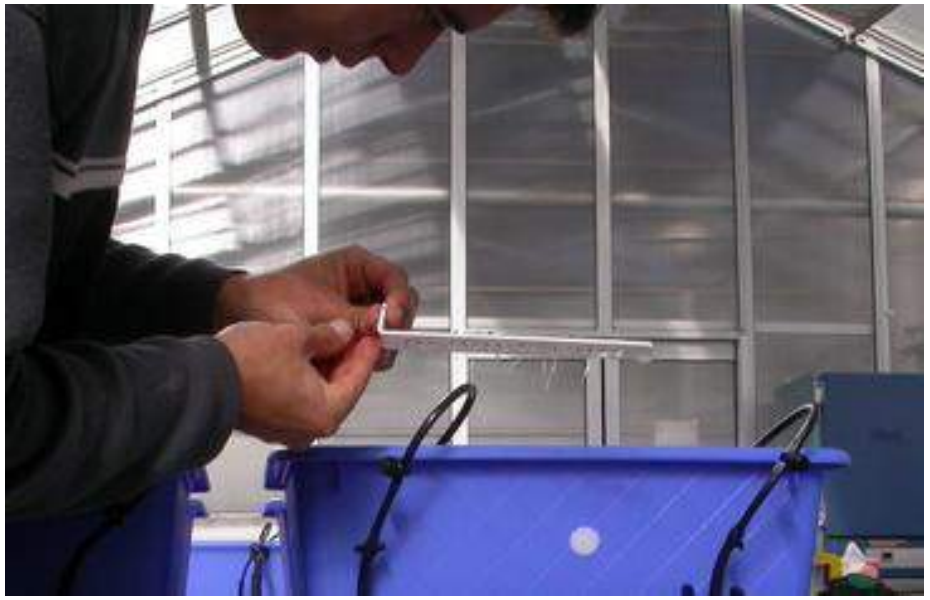
Identification of acid tolerant rhizobia

Selection for improved plant nodulation

1. The Screening System

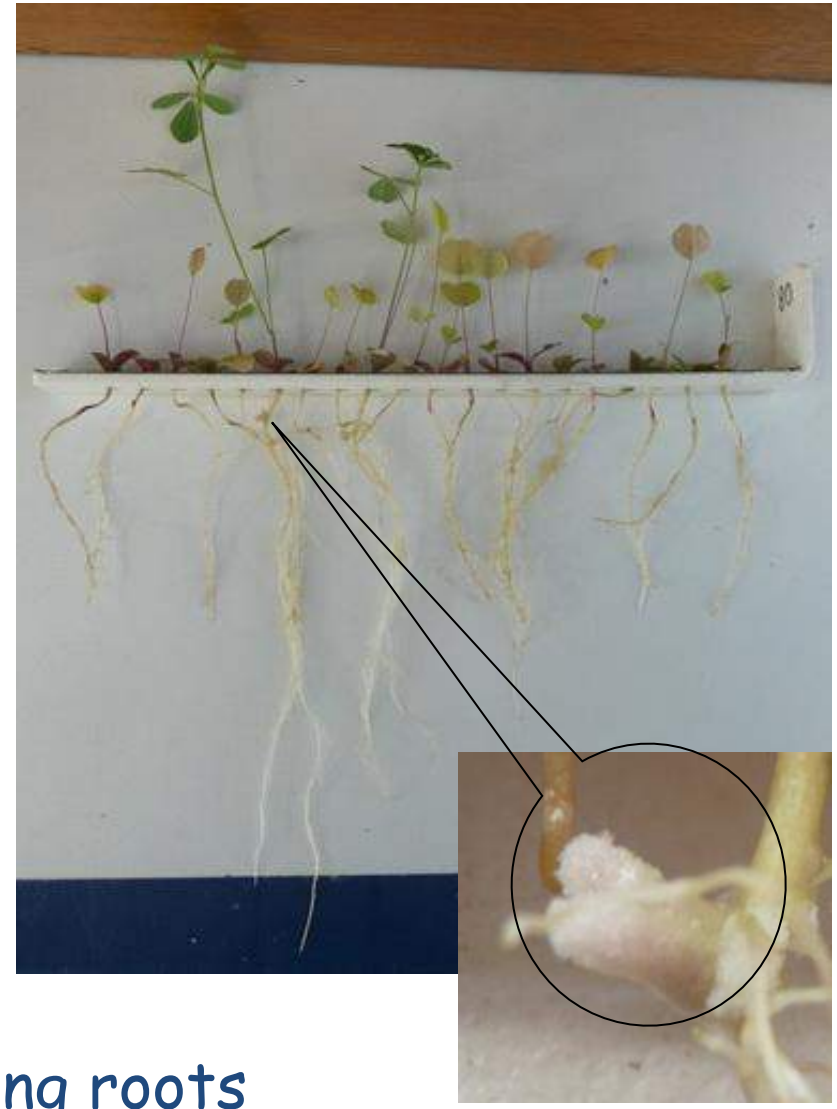
pH 4.5
25-75uMol Aluminum
Low ionic strength McNights solution (minus N)
2-3 weeks





2. Selecting the longest roots

multiple trait selection



Nodulated plants with long roots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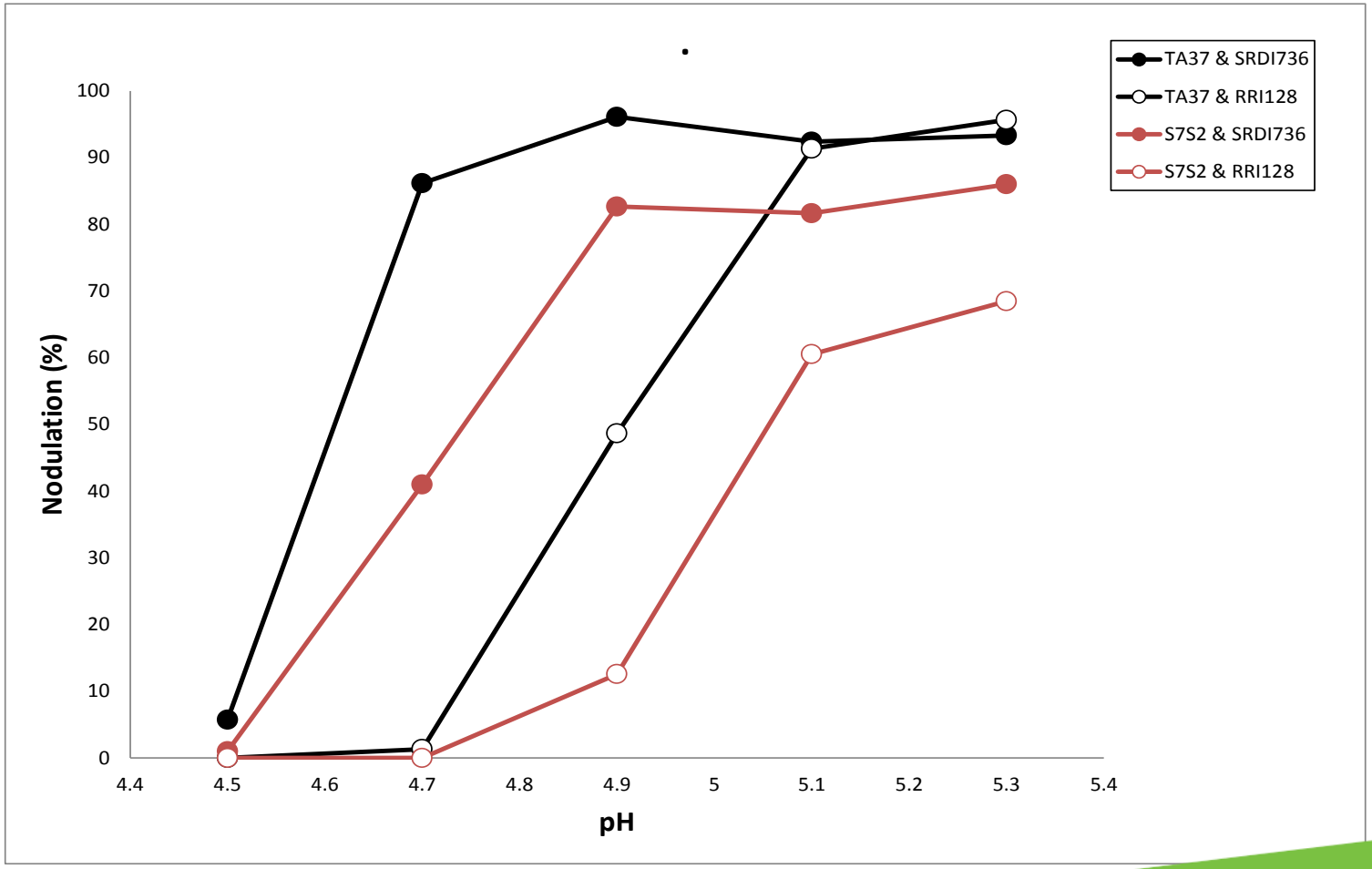
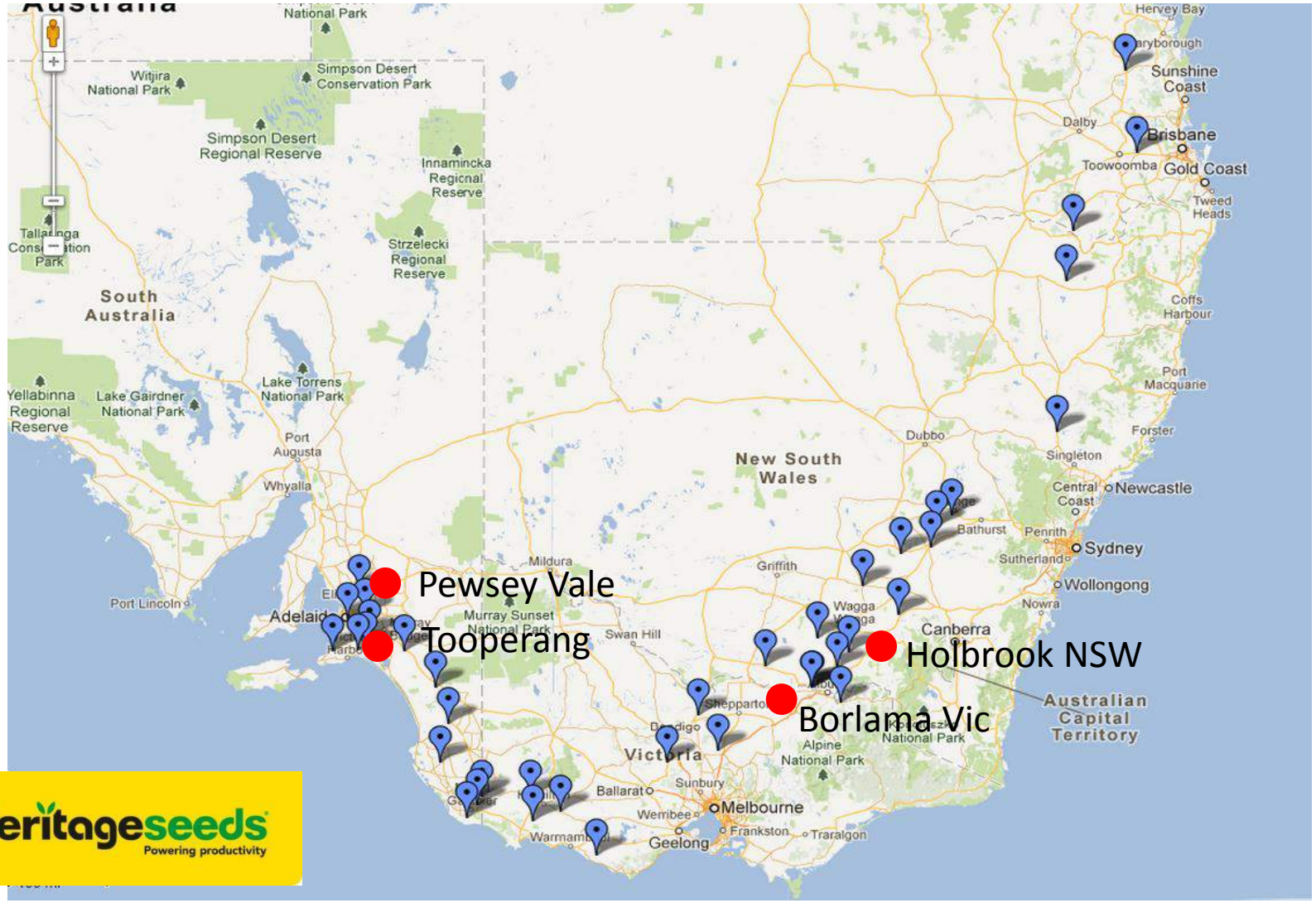
Average <2% nodulation
TA33
2 cycles selection for nodulation
~60% nodulation

Nodulation x pH in solution



SARDI/HS Lucerne Trial Locations



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Pewsey Vale Soil Analysis

Lime	*Depth*	*Nitrate*	*P*	*K*	*S*	*pH (CaCl2)*	*pH (H2O)*	*Exc. Al*	*CEC total*	*Al% CEC*
		mg/Kg	Colwell mg/Kg	Colwell g/Kg	mg/Kg	pH	pH	meq/100g	meq/100g	%
0	0 to 10	61	88	116	8.7	4.14	4.66	0.77	3.28	23.8
0	10 to 20	12	51	94	3.78	4.28	4.92	0.64	1.98	33.1
0	20 to 30	11	33	86	3.74	4.4	5	0.55	1.73	32.1
700	0 to 10	75	94	105	13	4.3	4.9	0.58	4.04	14.6
1400	0 to 10	82	91	104	13	4.4	5.0	0.54	4.29	12.7
2800	0 to 10	83	90	99	14	4.8	5.4	0.28	5.31	5.3

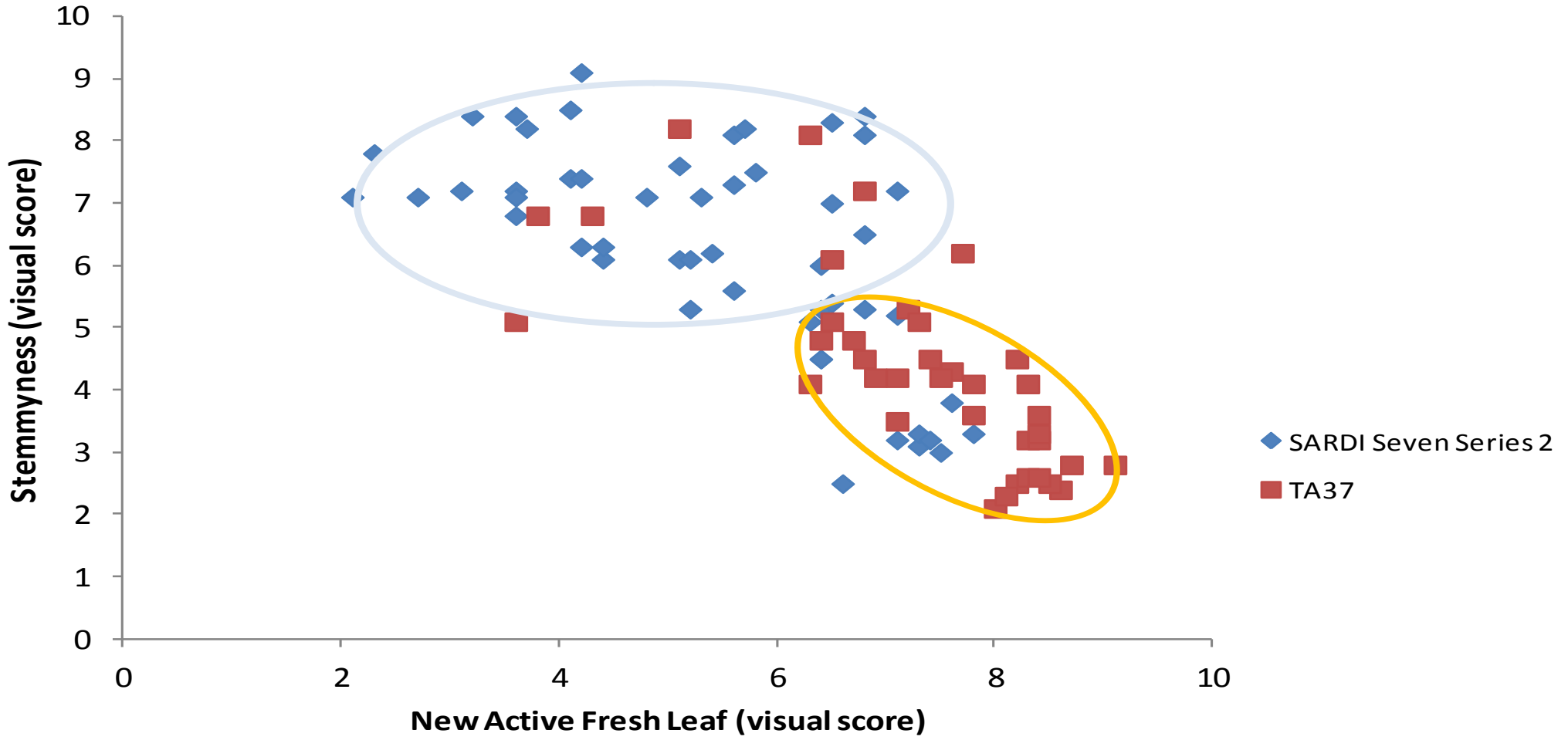
Impact of Lime on Establishment

Lime (kg/ha)	0	700	1400	2800
Density plants / m2				
Establishment	134	130	136	131
Autumn	82	90	102	88

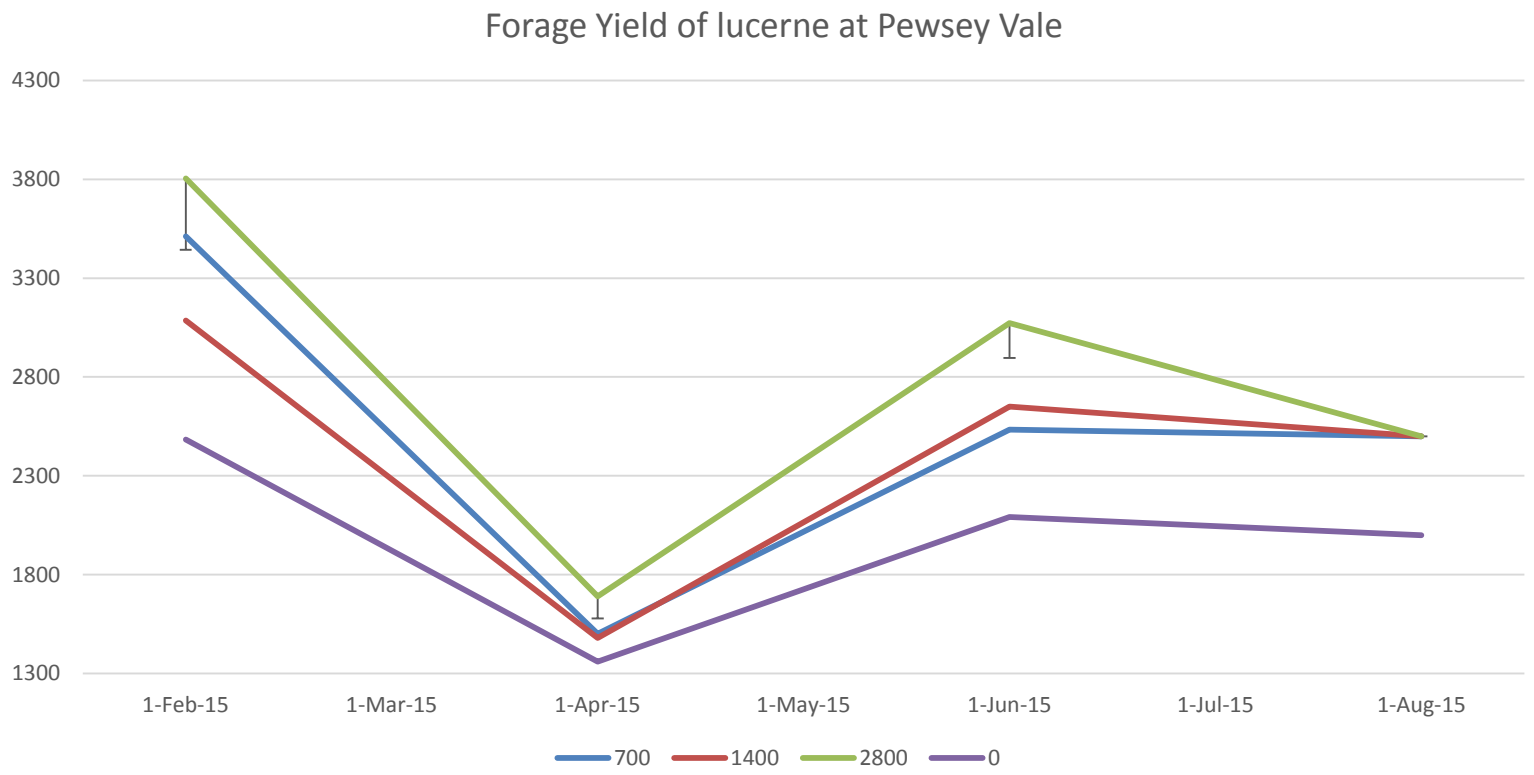
Impact of lime on nodulation

Lime rate (kg/ha)	0	700	1400	2800
pH	4.1	4.3	4.4	4.8
S7s2_nill	1	10	24	31
S7s2_RRI128	31	55	73	90
S7s2_SRDI736	38	78	95	83
TA37_SRDI736	60	77	92	86
5%lsd	18			

Visual options of new shoot growth in acid tolerant lucerne vesus SARDI 7 S2



Cumulative production 8-11 t/ha

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Summary: What have we learn't?

Lucerne is more adapted to acidic soils than previously recommended

- But we have a history in breeding for acidic soils (over 30 years)
- History of selecting rhizobia for acidic soils (last 20 years)

Acid tolerant Lucerne will deliver a futher small, incremental improvement in tolerance to acidic soils

- Nodulation (trait) benefit = higher N in soils
- Multiple stresses; acid, waterlogging, competition, grazing

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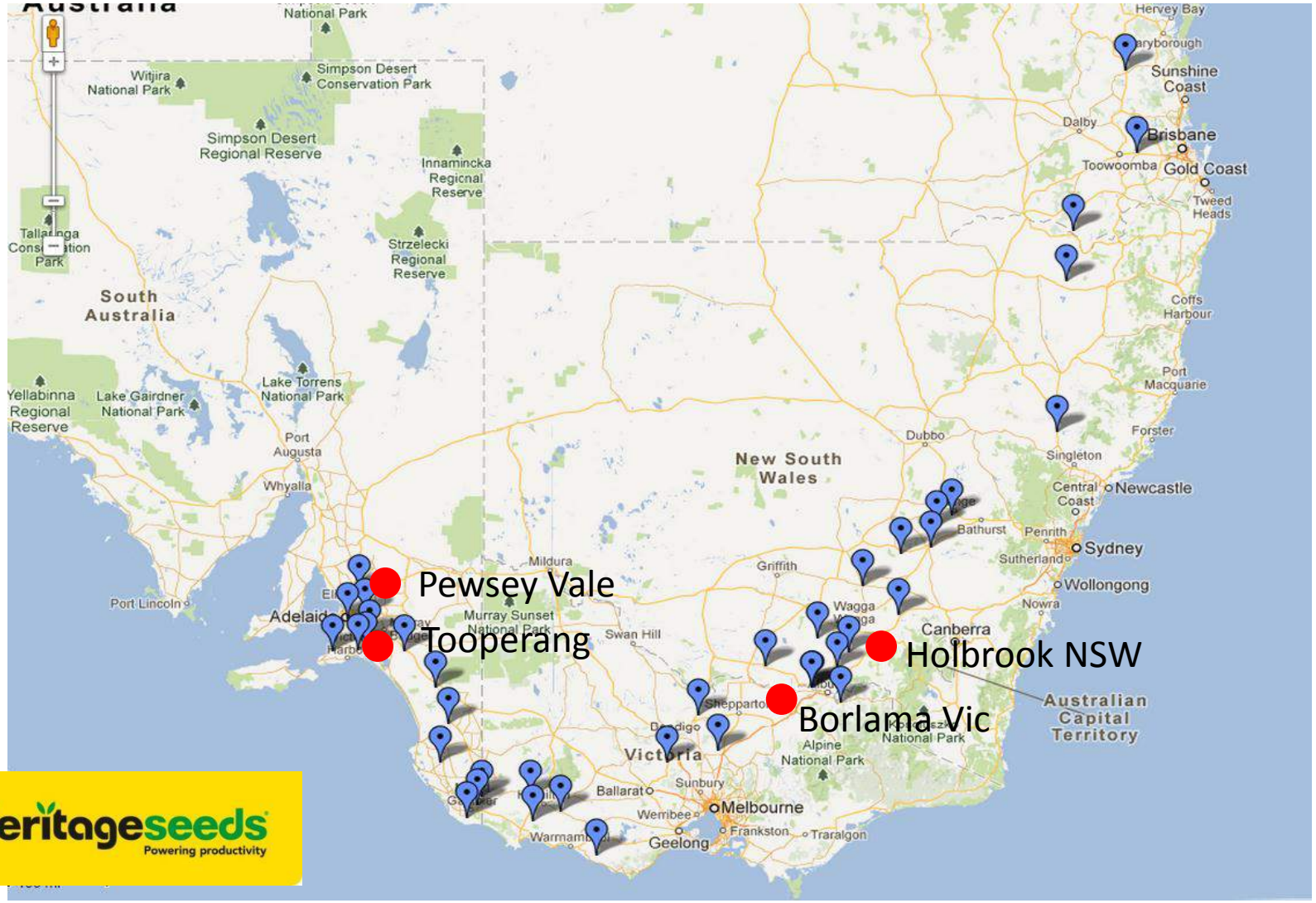
SARDI/HS Lucerne Trial Locations



https://www.google.com/maps/d/viewer?vpsrc=6&t=m&ll=-29.688053,143.920898&ie=UTF8&msa=0&spn=21.563209,43.286133&z=5&mid=zCWAZJ3u1tnQ.kYEumntAYtSU

Question? What pasture plant can grow 4-5 feet high in winter?

Sulla (Hedysarum)

Short lived perennial (2 years) with excellent winter and spring production on red brown earths

- Up to 20 t/ha in second year
- 450 mm AAR
- Excellent regeneration from seed
- Grazing / Hay / Silage

- **Negatives**
- Lack of registered herbicides
- Requires fresh rhizobia
- Seed expensive to dehull

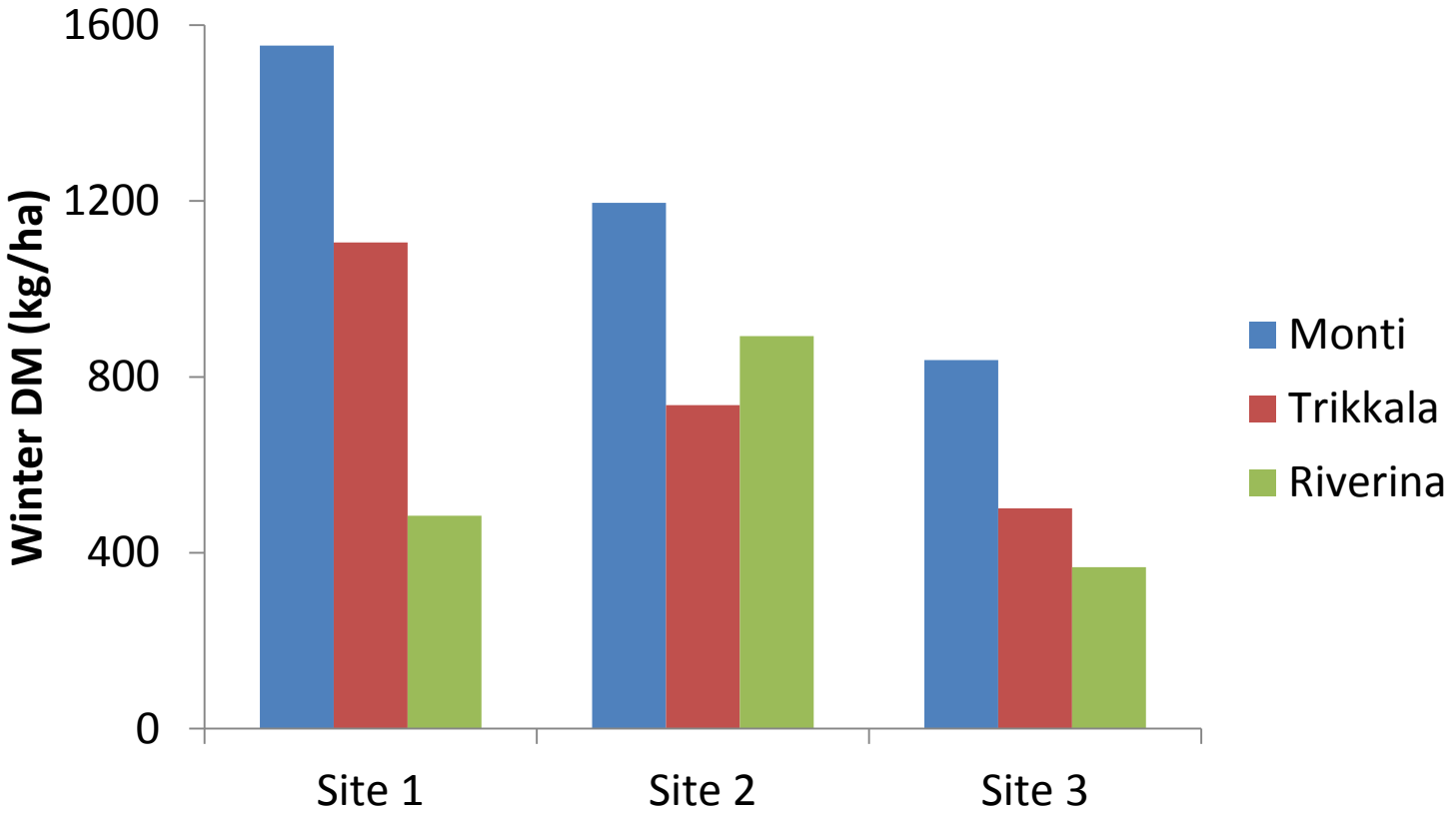

July 2015

8 new annual pasture cultivars

- **Monti : yan. subclover winter production** (Released 2013)
- **Sultan-SU : early residue tolerant barrel medic** (2015)
- **Vista : balansa clover, winter production and seed yield** (2016)
- **Mawson : early harder seeded brachy subclover** (2016)
- **Lofty : mid season brachy subclover** (2018)
- **Jester-SU : mid season residue tolerant barrel medic** (2018)
- **Powdery Mildew resistant strand medic** (2018)
- **“Messina” *Melilotus siculus*** (2016)

Monti subclover (ssp. *yanninicum*)

Reduces the feed gap in late autumn and early winter



- Resistance to phytophthora, clover scorch and pythium
- Earliest maturing `yan' cultivar => improved seed set under dry conditions

Andy Craig (et al)

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Two new subclover cultivars

Carolyn deKoning (et al)

Mawson

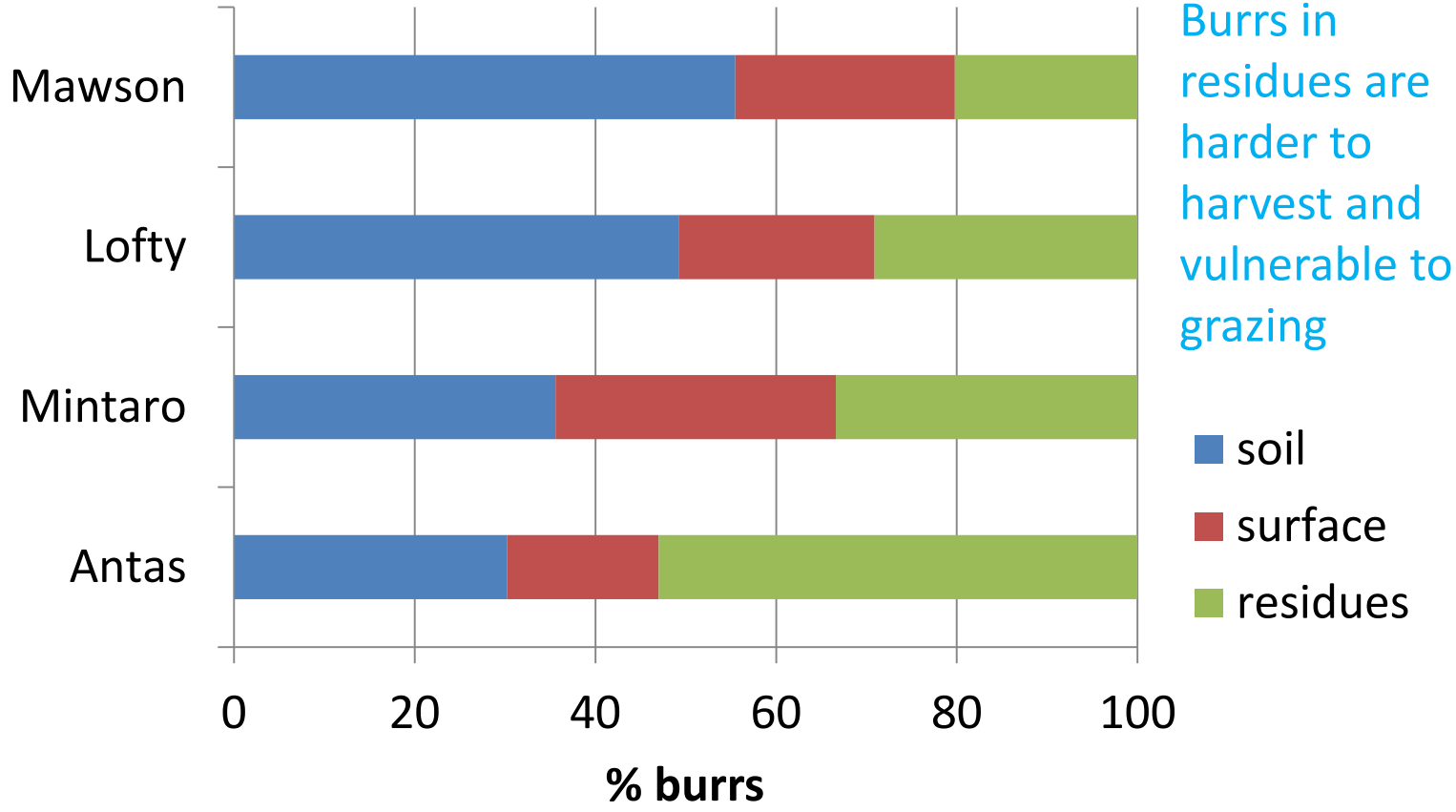
- Early season
- Moderate levels of hardseed (43% cf Antas 30%, Mintaro 58%)
- High winter production

Lofty

- Mid season
- Moderate levels of hardseed (38%)
- High winter production

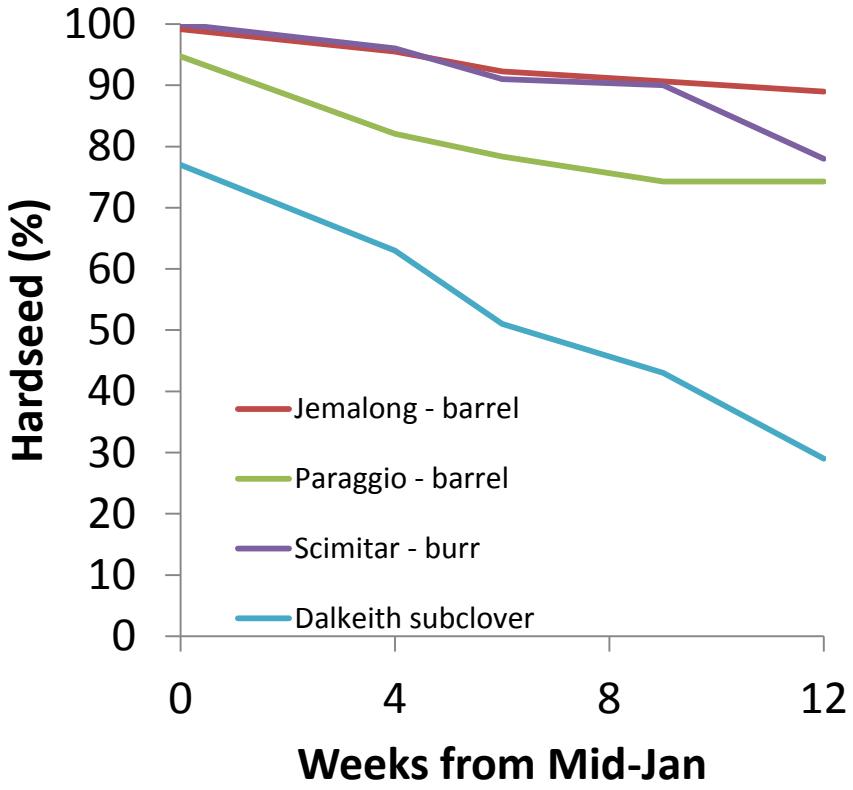
Mawson and Lofty (brachy.) have improved burr placement

Seed industry & persistence issue



Burrs in residues are harder to harvest and vulnerable to grazing

Hard seed



- Hard seed is a long term survival mechanism
- Hard seed breaks down in autumn with fluctuating temperatures
- Medics have higher levels of hard seed than subclover
- Ley farming system requires high levels of hard seed
- Higher levels required due to climate change

Acknowledgements

Funding from

Aust. Govt. funding via AusIndustry/Climate Ready program

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